

SECTION 15105

ABOVEGROUND PIPING SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

A. Scope

1. Refer to Division 15 Section “General Mechanical Requirements” for additional requirements.
2. Provide complete, operating piping systems with materials of construction and methods of fabrication, assembly, erection, testing and interim operation in compliance with the requirements specified herein and requirements of applicable codes and authorities having jurisdiction.

B. Description Of Systems

1. GENERAL

- a. The WORK for each system described herein includes, as appropriate to the design and location of the system, connections to existing work, required components, related work, including testing necessary to provide a complete functioning system.
- b. Ferrous piping systems 2” and under shall have threaded joints. Other joining methods may be required or allowed where indicated or specified.
- c. Metallic piping systems 2-1/2” and larger shall have flanged ends and welded joints. Other joining methods may be required or allowed where indicated or specified.
- d. Grooved-end piping, couplings and fittings, will be accepted only where specified.

2. CHILLED WATER (CHS, CHR)

- a. Piping. TYPE BCS-150, BLACK CARBON STEEL.
- b. Piping. TYPE CPR-BJ, COPPER BRAZED JOINT, use for piping sized 2” and under.
- c. Valves:
 - 1) Ball: BA-2, BA-2B for TYPE CPR-BJ piping. BA-1 for vent and drain service only.
 - 2) Butterfly: BF-1, BF-2 30-inch and larger option, BF-4 high performance for throttling service where indicated.
 - 3) Check: CK-1, CK-2, CK-18 silent non-slam for pump service.
 - 4) Gate: GA-1, GA-2.
 - 5) Plug: PL-1.
 - 6) Special Service: PCV
- d. Gaskets: TYPE NBR
- e. Bolts: High Strength.
- f. Special requirements: Shall be threaded, socket or butt welded, in sizes 2 inch and under. Provide grooved couplings and fittings only where shown on the DRAWINGS.

3. CONDENSATION DRAINAGE, COIL
 - a. Piping:
 - 1) TYPE CPR-DWV, COPPER DRAINAGE SYSTEM.
4. COOLING TOWER WATER (CWS,CWR)
 - a. Piping: TYPE BCS-150, BLACK CARBON STEEL.
 - b. Piping: TYPE CPR-BJ, COPPER BRAZED JOINT, use for piping sized 2" and under.
 - c. Valves:
 - 1) Ball: BA-2, BA-2B for TYPE CPR-BJ piping. BA-1 for vent and drain service only.
 - 2) Butterfly: BF-1, BF-4 where indicated.
 - 3) Check: CK-1, CK-2, CK-15 non-slam silent-check for pump service.
 - 4) Plug: PL-1.
 - d. Gaskets: TYPE CS.
 - e. Bolts: High Strength, except as otherwise specified for cast iron flanges.
 - f. Special requirements. Shall be threaded, socket or butt welded, in sizes 2 inch and under. Provide grooved couplings and fittings only where shown on the DRAWINGS.
5. FIRE PROTECTION:
 - a. See Division 15 Section "Fire Protection Systems."
6. INSTRUMENT AIR (CAI)(HCA)
 - a. Piping:
 - 1) TYPE BCS-150, BLACK CARBON STEEL.
 - 2) TYPE CPR-BJ, COPPER BRAZED JOINT. May be used in 2 inch and under piping.
 - b. Valves:
 - 1) Ball: BA-2, BA-4C. BA-1 for drain service.
 - 2) Butterfly: BF-1, where indicated.
 - 3) Check: CK-30.
 - c. Gaskets: TYPE CS.
 - d. Bolts: High Strength, except as otherwise specified for cast iron flanges.
 - e. Special Requirements:
 - 1) Steel pipe shall be threaded, socket or butt welded, in sizes 2 inches and under.
 - 2) Compressed Air system piping and components shall be "silicone-free" construction. Use of silicone lubricants or sealants is prohibited. Submit manufacturer's certification that components furnished are silicone free.
7. NONPOTABLE WATER (SWS)
 - a. Piping:
 - 1) TYPE GCS-150, GALVANIZED CARBON STEEL.
 - b. Valves:
 - 1) Ball: BA-2, BA-1 for vent and drain only.
 - 2) Butterfly: BF-1.
 - 3) Check: CK-1, CK-2.
 - 4) Plug: PL-1, PL-3A.
 - c. Gaskets: TYPE RR
 - d. Bolts: General Service, except as otherwise specified or required.
 - e. Special Requirements: Construct, disinfect as POTABLE WATER (PW).

8. POTABLE (DOMESTIC) WATER (CDW) (HDW)
 - a. Piping:
 - 1) TYPE GCS-150, GALVANIZED CARBON STEEL. For piping 2-1/2 inches and larger.
 - 2) TYPE CPR-SJ, COPPER SOLDER JOINT. For piping 2 inches and under or at CONTRACTOR'S option, in larger sizes.
 - b. Valves:
 - 1) Ball: BA-2, BA-2A, BA-9, BA-1 for vent and drain only.
 - 2) Butterfly: BF-1.
 - 3) Check: CK-1, CK-2, CK-15 non-slam silent check for pump service.
 - 4) Gate: GA-1, GA-2.
 - 5) Globe: GL-1, GL-2.
 - c. Gaskets: TYPE RR.
 - d. Bolts: General Service.
 - e. Special Requirements: Joint filler metal and piping components shall be lead free in compliance with NSF and EPA requirements. Use multiple head torches for copper joints sized 2-inches and larger. Grooved couplings, galvanized fittings are acceptable for cold water service. BIDDER may propose a VOLUNTARY ALTERNATE to provide TYPE GCS piping in lieu of TYPE CPR piping.
9. PUMPED CONDENSATE (PCR)
 - a. Piping: TYPE BCS-150, BLACK CARBON STEEL SYSTEM. Sch. 40. Shall be screwed, socket or butt welded.
 - b. Valves:
 - 1) Check: CK-1.
 - 2) Gate: GA-1.
 - 3) Globe: GL-8 at pressure gauges.
 - c. Gaskets: TYPE CS, (GRAF).
 - d. Bolts: General Service, except as otherwise specified or required.
10. ROOF CONDUCTOR (RC):
 - a. See STORM DRAINAGE (STW)
11. SANITARY DRAINAGE (GRAVITY) (SAN)
 - a. Piping:
 - 1) Type GCS-DWV, GALVANIZED CARBON STEEL DRAINAGE SYSTEM. Use for 2 inch and smaller drainage and vent piping.
 - 2) TYPE CISP-H, CAST IRON SOIL PIPE-HUBLESS. Use for 3 inch and larger drainage and vent piping.
 - 3) TYPE CISP, CAST IRON SOIL PIPE. Use for 3 inch and larger drainage and vent piping.
 - 4) TYPE SS-304L, STAINLESS STEEL PIPE. Where indicated.
12. SANITARY, (PUMPED) (SAN-P)
 - a. Piping:
 - 1) TYPE BCS-150, BLACK CARBON STEEL. Long radius butt weld or hydraulically bent change-of-direction, with chill-rings or consumable insert rings (no icicles) lateral inspection/clean out ports, piggable.

- b. Valves:
 - 1) Check. CK-34 with (Buna-N) sleeve designed for not less than 50 psi back pressure.
 - 2) Plug. PL-1.
 - c. Gaskets. TYPE NBR.
 - d. Bolts. General Service, except as otherwise specified or required.
 - e. Special Requirements. Construct piping bore and changes-of-direction to permit pigging without hang-up.
13. SONOXIDE SYSTEM PIPING
- a. Piping: TYPE PVC, POLYVINYL CHLORIDE, SCH-80.
 - b. Valves:
 - 1) Ball: BA-9.
 - 2) Check: CK-15F.
14. LOW PRESSURE STEAM AND CONDENSATE, (LPS)/(LPC), CONDENSATE RETURN VENT (CRV)
- a. Piping: TYPE BCS-LPS, BLACK CARBON STEEL SYSTEM. Shall be screwed, socket or butt welded in sizes 2 inch and under, butt welded or screwed in sizes 2-1/2" thru 5", and butt welded in sizes 6" and larger.
 - b. Valves:
 - 1) Check: CK-1, CK-2.
 - 2) Gate: GA-1, GA-2.
 - 3) Globe: GL-8 at pressure gauges, GL-6, GL-7.
 - c. Gaskets: TYPE CS, (GRAF).
 - d. Bolts: General Service, except as otherwise specified or required.
15. HIGH PRESSURE STEAM AND CONDENSATE, (IPS)/(IPC), SAFETY RELIEF VALVE VENT (PSV)
- a. Piping: TYPE BCS-IPS, BLACK CARBON STEEL SYSTEM. Shall be socket welded in sizes 2 inch and under, and butt welded in sizes 2-1/2" and larger.
 - b. Valves:
 - 1) Check: CK-1, CK-2.
 - 2) Gate: GA-1, GA-2.
 - 3) Globe: GL-8 at pressure gauges, GL-6, GL-7.
 - c. Gaskets: TYPE CS, (GRAF).
 - d. Bolts: General Service, except as otherwise specified or required.
16. STORM DRAINAGE (GRAVITY) (STW)
- a. Piping:
 - 1) TYPE GCS-DWV, GALVANIZED CARBON STEEL DRAINAGE SYSTEM. Grooved couplings and galvanized fittings are acceptable.
 - 2) TYPE CISP-H, CAST IRON SOIL PIPE-HUBLESS.
17. MISCELLANEOUS SYSTEMS/VENTS, DRAINS
- a. Piping: See Systems SPECIFICATIONS and DRAWINGS. Select from appropriate TYPE, materials systems.
 - b. Plumbing System Vents and Drains: Comply with applicable Code. Refer to Drawing for additional requirements.
 - c. Miscellaneous Systems Valves: See DRAWINGS. Select from System appropriate TYPE, materials, function.

- C. Related Work Specified Under Other Sections
 - 1. Division 15 Section “General Mechanical Requirements.”
 - 2. Division 15 Section “Underground Piping Systems.”
 - 3. Division 15 Section “Valves.”
 - 4. Division 15 Section “Piping Specialties.”
 - 5. Division 15 Section “Pumping Equipment.”
 - 6. Division 15 Section “Thermal Insulation.”
 - 7. Division 15 Section “Compressed Air Equipment.”
 - 8. Division 15 Section “Chemical Water Treatment.”
 - 9. Division 15 Section “Plumbing.”
 - 10. Division 15 Section “Steam and Condensate Specialties and Equipment.”
 - 11. Division 15 Section “Atmospheric Cooling Equipment.”
 - 12. Division 15 Section “Environmental Equipment.”
 - 13. Division 13 Sections for Instrumentation and Control Work.
 - 14. Division 16 Sections for Electrical Work.
 - 15. Division 09 Sections for Finish Field Painting.

1.2 QUALITY ASSURANCE

- A. Refer to Division 15 Section “General Mechanical Requirements” for applicable requirements.

1.3 SUBMITTALS

- A. Refer to Division 15 Section “General Mechanical Requirements” for applicable requirements.
- B. Include piping system layout drawings, piping sizes, calculations and coefficients used, materials and equipment classification and identification, component pressure/temperature rating, piping and equipment supports and restraints, special installation requirements, catalogue data and other data necessary to verify compliance with CONTRACT DOCUMENTS.
- C. Submit proposed proprietary supplementary structural members application.
- D. Fabricate mock-ups where specified or required.
- E. Submit proposed connections to building structure.
- F. *Test or Inspection Reports [T]:* Submit copies of structural integrity, leakage and performance and acceptance test data.

1.4 OPERATING AND MAINTENANCE PERSONNEL TRAINING

- A. Refer to Division 15 Section “General Mechanical Requirements” for applicable requirements.

1.5 PROJECT CONDITIONS

- A. Refer to Division 15 Section “General Mechanical Requirements” for applicable requirements.

1.6 GUARANTEE/WARRANTY

- A. Refer to Division 15 Section “General Mechanical Requirements” for applicable requirements.

PART 2 PRODUCTS

2.1 GENERAL

- A. Piping systems materials: Piping systems materials which are not manufactured in the U.S.A. shall be identified as such.
- B. *Bill of Materials [B]*: Submit source identification with bill of materials including documentation of compliance with specified criteria. Such materials shall be subject to testing sufficient to confirm compliance, as may be deemed necessary by the OWNER, and in the event of non-compliance, to subsequent removal/replacement, all, including testing, at no additional cost to the OWNER.
- C. Internally corroded pipe will be rejected.
- D. Refer to Division 15 Section “General Mechanical Requirements” for additional product requirements.

2.2 STEEL PIPE AND FITTINGS

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| A. Type BCS-150, Black Carbon Steel System | |
| 1. Pipe: | |
| 1/8 thru 3 | Schedule 40 or Schedule 80 black carbon steel; ASTM A 53, Type E. |
| 4 thru 10 | Schedule 40 black carbon steel; ASTM A 53, Grade B, Type E or S. |
| 12 thru 26 | 0.375 inch wall, black carbon steel; ASTM A 53, Grade B, Type E or S. |
| 28 and larger | 0.375 inch wall, black carbon steel; API 5L, Grade B, Type E or S, with mill varnish. |
| 2. Screwed couplings: | |
| 1/8 thru 2 | Extra heavy tapered thread black carbon steel. |
| 3. Screwed unions: | |
| 1/8 thru 2 | Class 300 female screwed malleable iron with ground joint and brass to iron seat, ANSI B16.39. |
| 4. Welded unions: | |
| 1/8 thru 1-1/2 | 2000 or 3000 PSI WOG, AAR, forged steel socket weld; ASTM A 105, Grade II and ANSI B16.11. |

5. Flanges:
2-1/2 and up

1. Class 150 or 300 RF forged steel slip-on or welding neck to match pipe wall thickness and valve flanges; ANSI B16.5 thru 24 inches; MS SP-44 for sizes over 24 inches.

2. For large diameter flanges, AWWA/ANSI to 144-inches; CM Flanges 800-435-2643; PEK 800-648-9597; CAB 404-934-3101.

6. Flanges, Orifice:

Class 300 forged steel, welding neck, to match pipe wall thickness, drilled, tapped, ANSI B16.36.

7. Screwed fittings:
1/8 thru 2

Class 150 WSP banded malleable iron screwed; ASTM A 197 and ANSI B16.3 rated 150 PSI at 350 degF and 300 PSI at 150 degF non-shock.

8. Welding fittings:

Steel butt weld to match pipe wall thickness; ASTM A 234 and ANSI B16.9. Weldolets are permitted up to 2/3 run size.

9. Socket fittings:

Forged steel; ASTM A 105, Grade II and ANSI B16.11, to match pipe wall thickness.

10. Bolts:

High strength, except where joining cast iron.

B. Type BCS-LPS, Black Carbon Steel System

1. Pipe:
1/8 thru 1

Schedule 80 black carbon steel; ASTM A 106, Grade B, Type S.

1-1/4 and larger

Schedule 40 black carbon steel; ASTM A 106, Grade B, Type S.

2. Screwed couplings:
1/8 thru 2

Extra heavy tapered thread black carbon steel.

3. Screwed unions:
1/8 thru 2

150 PSI WSP Female screwed bronze-to-iron ground joint seat, conforming to ANSI B 16.4.

a. Grinnell, Fig. 463.

4. Flanges:
2-1/2 and up

Class 150 RF conforming to ASTM A 105 and ANSI B16.5.

5. Screwed fittings:
1/8 thru 5

125 PSI WSP banded cast iron screwed; ANSI B16.4.

6. Welding fittings:
2-1/2 and up

Steel butt weld to match pipe wall thickness; ASTM A 234 and ANSI B16.9. Weldolets are permitted up to 2/3 of run size, extra strong class butt welding end connection, ASTM A 105 Grade II.

7. Bolts:

High strength.

C. Type BCS-IPS, Black Carbon Steel System

1. Pipe:
1/8 thru 2 Schedule 80 black carbon steel; ASTM A 106, Grade B, Type S.
2-1/2 and larger Schedule 40 steam service and Schedule 80 condensate service, black carbon steel; ASTM A 53, Grade B, Type S.
2. Welded unions:
1/8 thru 1-1/2 2000 PSI WOG, AAR, forged steel socket weld; ASTM A 105, Grade II and ANSI B16.11.
3. Flanges:
2-1/2 and up Class 150 RF conforming to ASTM A 105 and ANSI B16.5.
4. Welding fittings:
Up to 2 Class 3000 PSI forged steel, socket weld; ASTM A 105, Grade II and ANSI B16.11.
2-1/2 and up Steel butt weld to match pipe wall thickness; ASTM A 234 and ANSI B16.9. Weldolets are permitted up to 2/3 of run size, extra strong class butt welding end connection, ASTM A 105 Grade II.
5. Bolts: High strength.

D. Type GCS-150, Galvanized Carbon Steel System

1. Pipe: Schedule 40 galvanized carbon steel; ASTM A 53.
2. Screwed Fittings: Class 150 banded galvanized malleable iron screwed; ASTM A 197 and ANSI B16.3.
3. Screwed Unions: Class 300 female screwed malleable iron with ground joint and brass to iron seat, ANSI B16.39
4. Fittings:
2-1/2 and up Class 125 cast iron flanged fittings; ASTM A 126, Class A and ANSI B16.1.
5. Flanges: Class 150 flat or raised face as required, forged steel, screwed, ANSI B16.5.
6. Special requirements For cold water service, clean damaged galvanized surfaces oil-free with solvent and touch-up with a zinc rich coating or Type "A" primer.

E. Type GCS-DWV, Galvanized Carbon Steel Drainage System

1. Pipe: Schedule 40 galvanized carbon steel, ASTM A 53.
2. Fittings: Recessed pattern, cast iron, screwed, ANSI B16.12 or Class 125 cast iron flanges and flanged fittings, ASTM A 126, Class A, ANSI B16.1.
 1. At the CONTRACTOR'S option for storm service, mechanically coupled grooved type.
 - a. Victaulic.
 - b. Grukvlak.

2.3 CAST IRON PIPE AND FITTINGS

- A. Type CISP, Cast Iron Soil Pipe
 - 1. Pipe and fittings: Service weight pipe per ASTM A 74.
 - 2. *Elastomer gaskets [P]*: Per ASTM C 564.
- B. Type CISP-H, Cast Iron Soil Pipe - Hubless
 - 1. Pipe and fittings: Hubless per ASTM A 888 and CISPI 301, service weight pipe coated inside and outside with coal tar enamel. Pipe with eccentrically cast, thin walls will not be accepted.
 - 2. Joint: Conforming to CISPI 301 and ASTM A 888 use of a neoprene sleeve and two stainless steel clamps per joint.

2.4 COPPER PIPE AND FITTINGS

- A. Type CPR-BJ, Copper Brazed Joint System
 - 1. Tubing: Type L seamless copper tubing; ASTM B 88 hard drawn.
Annealed Type K; ASTM B 88 where indicated on the DRAWINGS.
 - 2. Pipe Nipples: Schedule 40 Red Brass or Copper.
 - 3. Brazing fittings: 150 PSI wrought copper socket joint; ANSI B16.22.
Cup depths and tolerances per MIL F-1183.
 - 4. Unions: 150 PSI wrought copper socket joint; ANSI B16.22.
Cup depths and tolerances per MIL F-1183.
 - 5. Flared fittings: 45 degree flared forged brass; ANSI B70.1.
 - a. Imperial-Eastman.
 - b. Crawford.
 - c. Parker-Hannifin.
 - 6. Flanges: Class 150 or Class 300 socket joint bronze ANSI B16.24.
- B. Type CPR-SJ, Copper Solder Joint System
 - 1. Tubing: Type L seamless copper tubing, ASTM B 88. Hard drawn for horizontal and exposed vertical lines.
Annealed or acceptable for small concealed lines.
 - 2. Solder fittings: 150 PSI wrought copper solder joint type, ANSI B16.22.
 - a. Mueller Brass "Streamline".
 - b. Nibco, Inc.
 - 3. Flared fittings: Cast bronze, ANSI B16.26; forged brass, ANSI B70.1.
 - a. Imperial-Eastman.
 - b. Nibco, Inc.

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| 4. | Compression fittings: | Sleeve compression type, brass. <ul style="list-style-type: none"> a. Crawford "Swagelok". b. Imperial-Eastman "Hi-Duty". c. Parker-Hannifin "CPI". |
| 5. | Pipe nipples: | Schedule 40 Red brass or copper. |
| 6. | Flanges: | Class 150 PSI WSP solder joint, ANSI B16.24. |

2.5 PLASTIC PIPE AND FITTINGS

- A. Type PVC, Polyvinyl Chloride Piping Systems
 - 1. Schedule 80 ASTM D-1785/Type 1 pipe and ASTM D-2467 socket joint fittings/flanges.
 - 2. Provide flanges where. specified; required; indicated; at all transitions to other piping materials. Provide service/duty required gasket materials. Use ANSI Class 150 drilling steel flange backing rings for all flanges, of 1/8 thru 1/2-inch thickness, as required by flange size and as manufactured by. Chicago Rolled Products (312-523-5757); National Metal Fabricators (312-439-5321/800-323-8849); Felker Alloy Products (715-384-3121); CONTRACTOR fabricated.
 - 3. Primer and solvent cement shall be provided by pipe supplier.
- B. Type PVC-DWV, Polyvinyl Chloride Drainage System
 - 1. 1. Pipe, Fittings and Joining Materials: Per ASTM D 2665.
 - a. a. Chemtrol.
 - b. b. Genova.
 - c. c. Spears.

2.6 STAINLESS STEEL PIPE AND FITTINGS

- A. Type SS-304L
 - 1. Pipe:

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| | Schedule 40S, stainless steel, ASTM A 312, Grade 304L, ANSI B36.19, seamless. |
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 - 2. Welding fittings:

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| All sizes | Stainless steel, butt weld, long radius, ASTM A 403, WP 304L, ANSI B16.9, B36.19 to match pipe wall thickness. |
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2.7 PIPE SUPPORTING ELEMENTS

- A. General
 - 1. Furnish supporting elements per ANSI B31.1 with Addenda, MSS SP-58, and MSS SP-69, except as otherwise modified and supplemented herein. Supporting elements, including structural members, rods, threaded fasteners, "U" bolts, etc., exposed to weather shall be hot dip galvanized after fabrication. Stainless steel components are acceptable in lieu of hot-dip galvanized carbon steel. Use of raw carbon steel fasteners in weather exposed locations is prohibited. Copper piping or tubing shall be isolated from supports by plastisol coatings or rubber or plastic insert. Pre-insulated supports exposed to weather shall have a weatherproof jacket.

B. Designation And Manufacturers

1. "TYPE" designations are based on MSS SP-58 and MSS SP-69. Support elements, except for mill rolled supplementary steel, shall be catalogued, load rated, commercially manufactured products. Refer to following "MANUFACTURER'S EQUIVALENTS" for additional information relative to "TYPE" and models.

C. Building Structure Attachments

1. Anchor Devices, Concrete and Masonry: Per Group 1, Group II, TYPE 2, Class 2, Style 1 and Style 2, Group III and Group VIII of FS FF-S-325A. Furnish cast-in floor type equipment anchor devices with adjustable positions. Furnish built in anchor devices for masonry.
2. Beam Clamps: Center loading TYPE 21, 28, 29, and 30, unless otherwise specified or indicated. When it is determined by the OWNER that it is not possible to use center loading beam clamps, eccentric loading beam clamps, TYPE 20, 25, and 27 may be used within the following limitations. for loads equivalent to water piping sizes 2 inches and less; for loads equivalent to water piping sizes 2 inch through 10 inch provided two counterbalancing clamps are used per point of pipe support and pipe is mounted on trapeze. Where more than one rod is used per point of support, determine rod diameter per referenced standards. Miscellaneous structural steel, cantilevered from a structural beam in order to support piping, is prohibited.
3. "C" Clamps. Use of "C" clamps and beam clamps of "C" pattern and any modification thereof is prohibited.

D. Horizontal Pipe Attachments

1. SINGLE PIPES

a. General Determination of Hanger Types:

- 1) Where horizontal thermal movement at point of support does not exceed one inch. Use combination TYPE 1 attachment and TYPE 40 protection shield, for insulated cold piping; use TYPE 3 attachment, clamped directly to pipe, for insulated hot piping; use TYPE 1, TYPE 3, or TYPE 4 attachment for insulated bare piping.
- 2) Where horizontal thermal movement at point of support exceeds one inch, hanger components, including weldless eye nuts, shall be selected to allow swing of the hanger rod. Use TYPE 3 attachment clamped directly to pipe, or combination TYPE 41 attachment and TYPE 39 protection saddle for insulated hot piping. Use combination TYPE 4 attachment and 360 degree protection shield for insulated cold piping. Use TYPE 4 attachment for bare piping.
- 3) Where horizontal thermal movement at point of connection exceeds two inches, pre-set positions of pipe clamp and structural attachments to allow equal swing of the hanger rod, either side of vertical, from the cold position to the hot position.
- 4) Where axial thermal movement at point of support would cause a hanger rod to swing more than 4 degrees from vertical, or where thermal movement exceeds 5 inches, a TYPE 58 overhead roller traveling device with antifriction bearings (device shall be welded to miscellaneous steel) or a roller hanger shall be used. Roller hangers for 6 inch pipe and under shall be TYPE 43 with swivel. Roller

- hangers for 8 inch pipe size and larger shall be TYPE 41. Do not use fixed rollers where lateral pipe movement occurs.
- 5) Provide TYPE 39 insulation protection saddles, minimum of 12 inches long, for hot insulated pipe on rollers. Tack weld saddle to pipe.
 - 6) For roller support of cold insulated piping, provide pre-insulated supports with integral shield and vapor barrier. Shield thickness and length shall be suitable for point loading roller application.
 - 7) TYPE 39 protection saddles, and integral insulation shields shall have a length sufficient to keep the rolling point of contact at least 2-1/2 inches from either end of the saddle or shield.
- b. Supports for insulated and continuously vapor-barrier sealed cold piping.
- 1) Support 2 inch and smaller insulated and vapor sealed lines by manufacturer's standard TYPE 40 insulation protection shields applied under the specified pipe insulation.
 - a) Anvil International Fig. 167.
 - b) Bergen-Power. Fig. 136.
 - 2) Support cold vapor sealed piping 2-1/2 inch and over, except as otherwise indicated on the DRAWINGS, by a combination TYPE 1 or 3, pipe attachment and asbestos free pre-insulated pipe support with vapor barrier, integral shield, and load rated for the design load. Insert shall be 180 or 360 degree high density molded polyurethane foam with compressive strength/length required to carry imposed load, with safety factor for possible unloaded supported.. The length and compressive strength of the insert, in conjunction with the insulation shield, shall be sufficient to support the pipe at the specified span with not more than 5% deformation and with a safety factor for a possible unloaded adjacent support, without crushing of the insert or breaching of vapor barrier continuity.. The approved manufacturers of cold pipe hanger supports for each type of pipe attachment, are as follows:
 - 3) For use with the TYPE 1 pipe attachment, use the 180 degree insert with shield, or use the 360 degree insert with 180 degree shield, unless otherwise shown on the DRAWINGS:
 - a) Bergen-Power Powerfoam Hanger No. 9052 for 180 degrees, No. 9053 for 360° degrees.
 - b) Pipe Shields, Inc. with TYPE 1 hanger as follows:
 - 3 inch and 4 inch Pipe Size Model A 2000
 - 6 inch Pipe Size Model A 4000
 - 8 inch Pipe Size Model A 9000
 - c) Pipe Shields, Inc. with TYPE 4 pipe attachment, Model D 3000 Series, instead of TYPE 1 pipe attachment, is acceptable for pipe sizes 5 inches and over.
 - d) Rilco Mfg. Co. Inc. with TYPE 1 hanger as follows:
 - 3 inch and 4 inch Pipe Size Model HC 2000.
 - 6 inch Pipe Size Model HC 4000
 - 8 inch Pipe Size Model HC 9000

- 4) For use with TYPE 3 or TYPE 4 pipe attachment, use the 180 degree insert with shield on both the top and the bottom of the pipe, as follows:
 - a) Bergen-Power 180 degree Powerfoam Unit No. 9050 for each top and bottom.
 - b) Pipe Shields, Inc.
 - 1/2 inch - 4 inch Pipe Size Model D 2000 Series
 - 5 inch and over Pipe Size Model D 3000 Series
 - c) Rilco Mfg., Co. Inc.
 - 1/2 inch - 4 inch Pipe Size Model HH 2000 Series
 - 5 inch and over Pipe Size Model HH 3000 Series
- c. Use spring supports as Scheduled and shown on the DRAWINGS.
 - 1) Variable spring hangers shall not be loaded to more than 75% of published load rating, and shall not exceed 25% allowable load change variability per referenced MSS Standards SP-69 Table No. 2
 - 2) Provide spring supports with overload stops for hydrostatically tested piping including (liquid,) gas, vapor, or vacuum piping.
 - 3) Spring supports for steam lines shall be based on empty pipe plus insulation. The spring container, attachments, and rod size shall be based on the weight during hydrostatic test.
2. PARALLEL AND SINGLE PIPES
 - a. Fabricate trapeze hangers from approved structural steel shapes per "SUPPLEMENTARY STEEL" requirements or use of commercially available, proprietary design, rolled steel. Refer to applicable requirements for "SINGLE PIPES". 360 degree shields or other approved may be used on trapeze where TYPE 24 "U" bolts are indicated. Refer to details on the DRAWINGS.

E. Vertical Pipe Attachments

1. TYPE 42 or spring type to meet system requirements.

F. Sliding/Guiding Devices

1. General:
 - a. Furnish pre-engineered commercially available products with published load ratings.
 - b. For outdoor weather exposed shoe type supports and for indoor shoe type supports for hot pipes, provide 25% glass filled teflon members (bonded to steel mounting plate) in sliding contact with AISI TYPE 300 Series stainless steel, except where the DRAWINGS specifically indicate graphite to graphite plates. The horizontal stainless steel surface shall be designed to prevent scoring and damaging the teflon slide surface. For guide shoes, the mounting plate shall incorporate factory installed lateral and vertical restraint devices. Protect assembly from dirt and freezing water intrusion, and prevent line contact of sliding surfaces. For pipe temperatures above 366 degF, mechanically bond the teflon (or graphite) members to the steel plate in addition to using high temperature bonding adhesive.
 - c. Material and design for support shoes shall be as follows:
 - 1) Slide Metal: AISI TYPE 304 stainless steel with No. 2B finish.

- 2) Slide Pad: 25% glass filled teflon for dimensional stability and resistance to wear. The pad sizes and thickness shall be as determined by the manufacturer to meet the design requirements.
 - 3) Sliding base shall totally cover supporting contact surface in all positions of thermal movement except for lateral sliding supports.
 - 4) Compressive load on teflon pad shall not exceed 350 PSI, and shall be at least 75 PSI. Units which have a lateral movement in excess of $\pm 1/2$ inch; and pipes 2-1/2 inches and smaller do not require a minimum loading.
 - 5) Attaching hardware and protective coatings for outdoor service shall be as specified in the opening general statement of Article "PIPE SUPPORTING ELEMENTS".
- d. Unless otherwise noted, support shoes indoors and outdoors shall be welded to the pipe per support detail types G4, G4A, G5 and G5A.
 - e. Non guided support shoes for domestic water and non potable water shall be type G2A (with shoe welded to the insulation shield.) Guide support shoes shall be type G4 (with shoe welded to the pipe.)
 - f. Cold and ambient indoor support shoes shall omit the weather proof jacket and the stainless steel to teflon or graphite to graphite sliding plates. The greased metal shoe plate will slide directly on the structural steel (or miscellaneous steel.) The sliding surfaces shall be lubricated with a molybdenum disulfide grease such as Dow Corning Co. BR2-PLUS.
2. Outdoor, weather exposed shoe supports, and indoor shoe supports for hot pipe.
 - a. Use support details type G4, G4A, G5 and G5A, with stainless steel sliding on teflon.
 - b. Indoor Hot Pipes:
 - 1) Same as specified for outdoor weather exposed supports with support shoe welded to the pipe, except that weather proof jacket is not required.
 - 2) As an alternate for straight runs of indoor pipe where lateral movement is 1/2" or less, pipe may be supported by pipe roller stands installed underneath type 39 insulation protection saddles.
 - c. Where vapor sealed pipes are welded to support shoes, such as types 4, 4A, 5 and 5A insulate and vapor seal per detail G-7 as follows:
 - 1) Fill shoe cavities with foamed-in-place polyurethane.
 - 2) Insulate the shoe surfaces and contiguous pipe with cellular elastomer to match the thickness of the adjacent pipe insulation.
 - 3) The cellular elastomer shall be installed with adhesive on 100% basis.
 - 4) Apply a 4" wide by 3/8" thick closure strip of elastomer over the abutting insulation materials.
 - 5) Refer to Division 15 Section "Thermal Insulation" for additional vapor barrier continuity requirements.
 - d. Manufacturer:
 - 1) Bergen-Power, Unislide.
 - 2) Advanced Thermal Systems Co.
 3. Where shoe support detail type G2 or G2A is indicated on the drawings:
 - a. The insulated shield portion of the support shall consist of two 180 degree high density asbestos free insulation halves with necessary insulating structural inserts to meet the design loads of Table II. The manufacturer shall provide a vapor barrier, a

- galvanized steel weathertight insulation jacket, and a 360 degree galvanized steel outer shield. No metal contact heat path from pipe to outer surface of insulation is permitted. The weathertight jacket shall extend 1" beyond the shield. The vapor barrier shall extend 2" beyond the shield. The shield shall be clamped tight and clamping bolts shall be torqued to the manufacturers recommendations to fully force the rigid insulation against the pipe.
- b. A structural support shoe with a stainless steel horizontal sliding surface shall be welded to the clamps or to the outer shield.
- 4. Insulation for pre-insulated pipe supports:
 - a. Structural Inserts. asbestos-free, water-resistant, very high-density, high-strength (min. 600 PSI compressive strength) calcium silicate, or manufacturer's high density molded rigid polyurethane foam with a minimum density of 10 lbs./cu. ft.
 - b. All other insulation. asbestos-free, water-resistant, molded high-density (13 lbs/ft³) calcium silicate, or rigid molded polyurethane foam.
 - 5. Adhesive for bonding insulation to jacket. High-performance, structural, industrial contact cement (minimum peel strength 23 lbs. per inch of width after 3 weeks at 75 degF).
 - 6. For other materials, refer to the General statements for sliding/guiding devices.
 - 7. Manufacture:
 - a. Pipe Shields, Inc., Model "B" Series.
 - b. Bergen-Power., Unislide No. 7420-T & 7460-T.
 - c. Rilco Mfg., Co. Inc., HS and HG.
 - 8. For uninsulated and insulated hot piping systems where the support shoe is indicated on the DRAWINGS as welded to the pipe or to the pipe reinforcing pad, furnish pre-engineered commercially available products with published load ratings constructed to include 25% glass filled teflon members in sliding contact with AISI TYPE 300 Series stainless steel. Protect assembly from dirt and prevent contact of sliding structural surfaces.
 - a. Bergen-Power, Unislide.
 - b. Pipe Shields, Inc., Powerslide.
 - c. Rilco Mfg., Co. Inc., Low Friction.
- G. Hanger Rods And Fixtures
- 1. Use only circular cross-section rod hangers to connect building structure attachments to pipe support devices.
 - 2. Furnish turnbuckles, weldless eye nuts and clevises. Rod couplings are not acceptable. All screwed and equivalent adjustments shall be provided with suitable locking devices.
 - 3. Manufacturer's Equivalents
 - a. Pipe Hangers and Spring Supports:
 - 1) Carpenter & Paterson.
 - 2) Anvil International.
 - 3) B-Line.
 - 4) Michigan Hanger.
 - 5) Rilco Mfg. Co. Inc.
 - b. Pre-insulated Hanger Supports with Vapor Barrier as specified above:
 - 1) Bergen-Power.
 - 2) Pipe Shields Inc.

- 3) Rilco Mfg. Co. Inc.
4. The following tabulation is for information; it does not include provisions for variations in load carrying capacity or application variations. Equivalent units per the previously noted acceptable manufacturers may be used.

SUPPORTING ELEMENT EQUIVALENTS

| MSS-SP-58 | GRINNELL- ANVIL INTERNATIONAL | CARPENTER & PATERSON | RILCO | POWER PIPING |
|-----------|-------------------------------------|-------------------------|---------|--------------|
| 1 | 260 | 100 | 380 | 11 |
| 3 | 295 | 304 | 310 | 222 |
| 8 | 261 | 126 | 360 | 36 |
| 20 | 225 | 45 | 132 | -- |
| 21 | 134 | 15 | 128 | 41 |
| 25 | 227 | 18 | 135 | -- |
| 28 | 292 | 297 | 141/142 | -- |
| 30 | 229 | 82,293 | -- | -- |
| 41 | 171 | 142 | 545 | -- |
| 44 | 271 | 17 | 500 | 18 |
| 49 | 178 | 478 | 550 | 180 |
| 50 | 296 | -- | 830 | 1700 |

5. Alignment Guides: Factory fabricated unit consisting of a bolted spider and a bolted guiding cylinder with supporting legs welded to pipe support.
 - a. Bergen-Paterson, Inc.
 - b. Carpenter & Paterson.
 - c. Anvil International.
 - d. NPS Industries
 - e. Power Piping Co.
 - f. Pipe Shields.

H. Supplementary Steel

1. Supplementary steel: Design and fabricate per the American Institute of Steel Construction Specification for the Design, Fabrication and Erection of Structural Steel for Buildings.
2. Shop or field prime coat for interior to building spaces and hot dip galvanize, normally after fabrication, for exterior to building services.
3. Prefabricated, pre-engineered steelwork fixings to securely affix supplementary steel to building without drilling or welding of building steel.
 - a. Lindapter.
 - b. Other approved.

I. Proprietary Supplementary Structural Members

1. *Prefabricated or Pre-Engineered Channel (Strut) Framing Systems [D,P]*: When proposed in lieu of supplementary steel, submit proposed application for approval.
 - a. Unistrut.
 - b. Globe Strut.
 - c. Superstrut.

- d. Hilti.

PART 3 EXECUTION

3.1 GENERAL

- A. Execute the WORK in compliance with Division 15 Section “General Mechanical Requirements .”

3.2 PIPING SYSTEMS INSTALLATION

A. General

1. Construct piping systems in accordance with ANSI B31.1 latest edition and supplementary requirements specified herein.
2. Install off-ground pipe storage and pipe cleaning stations acceptable to OWNER, comprised of cleaning means/devices which include punch-out brushes; high pressure compressed air lances; high pressure water (to 30,000 psi). The objectives are to install piping systems so clean that WORK under Article “Field Quality Control” and resultant waste water is minimized and such that OWNER rejection of dirty installation work is simultaneously minimized. Need for pipe cleaning station may be minimized upon OWNER approval if fresh mill-run and end-sealed pipe is furnished.

B. Fabrication, Assembly, Erection

1. Clean pipe, tubing, fittings, valves, equipment and accessories of extraneous foreign material and dry the components before installation into their respective systems. During construction, protect open ends of pipe, fittings and valves to prevent the admission of foreign matter. Place plugs in the ends of installed work at the end of the day and whenever work stops. Use commercially manufactured plugs. Fabricate pipe to measurements established on the project site; work pipe into place without springing or forcing. Provide for absorbing movement without undue stress in any part of the system.
2. Install piping straight and true, with approved offsets to increase headroom and avoid obstructions. Pipe installation shall clear electrical bus ducts by 4’-0” unless otherwise approved. Provide shielding/pans where crossing over electrical bus ducts and specified drainage and venting where piping offsets are required.
3. Use standard long sweep pipe fittings for changes in direction. No mitered joints or field fabricated pipe bends will be permitted. Short radius elbows may be used where specified or specifically authorized by the ARCHITECT-ENGINEER. Copper tubing may be bent in the field with the use of approved tube bending equipment.
4. Make tee connections with screwed tee fittings or specified welded connections. Make welded branch connections with either welding tees or forged branch outlet fittings per ASTM A 105, ANSI B16.9 and ANSI B16.11. For forged branch outlets, furnish forged fittings flared for improved flow where attached to the run, reinforced against external strains and to full pipe-bursting strength requirements. “Fishmouth” or “Saddled-In” connections are not acceptable.
5. Take off branches from mains at an angle of 45 degrees or 90 degrees above horizontal, unless otherwise indicated. Pitch up branches taken from the tops of mains, pitch down

those taken from the bottom of the mains. Make connections to eliminate air pockets, insure unrestricted circulation and complete drainage of the system.

6. Provide unions or bolted flanges to permit removal of equipment, valves and piping accessories from the piping system. Make final connections to equipment with unions or flanges located between equipment and valves.
7. Use eccentric reducers for drainage and venting of pipe lines; bushings are not permitted.
8. Expansion bend configuration shall be as indicated. Make expansion U-bends from pipe sections and long radius welding elbows. Cold spring expansion bends with indicated cold spring and weld into the line, which shall be anchored before removing the spreader from the expansion U-bend.
9. Upon prior approval and within systems limitations, make pipe bends of Grade A seamless, or where approved of electric resistance welded pipe, of not less than five pipe diameters radius by cold bending with hydraulic benders for pipe sized to 4 inch NPS. Bent pipe with wrinkles, kinks, flattening, wall thickness variation and other defects will be rejected.
10. Anchor rain conductors to building structure near roof drain to protect roof drain from pipe expansion stresses.
11. Horizontal piping containing liquids and vapors condensable at system ambient conditions shall have a grade of 1 inch per 40 feet.
12. Horizontal piping containing noncondensable gases shall have a grade of 1 inch per 100 feet.
13. Slope horizontal drain and waste piping in the direction of flow not less than minimum grade required by applicable code.

C. Joints

1. Ream pipe ends. Make up screwed joints with joint compound. Apply joint compound to the male thread only; prevent compound from reaching the interior of the pipe. Provide leak-tight joints without stressing fittings.
2. Where required, make up screwed joints with Teflon tape per manufacturer's instructions.
3. Assemble flanged joints per ANSI/ASME B31.1, ANSI/ASME B16.5 and NFPA 30, 50, 51, 58, as applicable. Clean all flange serrations of leak causing filler and inspect for damage. Assemble flanged joints with fresh-stock gasket and specified hex head nuts, bolts or studs. Make clearance between flange faces such that the connections can be gasketed and bolted tight without strain on the piping system. Align flange faces parallel and bores concentric; center gaskets on the flange faces without projection into the bore. Apply graphite to both sides of steam piping joint gaskets. Use 1/16 inch sheet gasket, except as otherwise specified.
4. Use high strength bolting ASTM A 193/194, per ANSI B31.1 TABLE 108.52 preferentially to ASTM A307 general service bolting except where ANSI B16.1 Class 125 and special case Class 250 cast iron flanges occur. Use stainless steel bolting with specified corrosion resistant system. Lubricate carbon steel bolts with oil and graphite before assembly to insure uniform bolt stressing. Draw up and tighten bolts in staggered sequence to prevent unequal gasket compression and deformation of the flanges. Do not mate a flange with a raised face to a companion flange with a flat face; machine the raised face down to a smooth matching surface and use a full face gasket. After the piping system

has been tested and is in service at its maximum temperature, check bolting torque to provide required gasket stress.

5. Use professional quality torque wrenches to confirm/develop required gasket stress initially. If it is necessary to use 1/8" thick gasket, increase torque by nominal 30%. Retorquing a used heated or leaking gasket may cause cracking. Use high strength bolting as specified.
6. Cut copper tubing square for socket joints; remove burrs with approved cutting and reaming tools. Clean inside of fittings and outside surfaces of tubes in joint area with stainless steel wool before assembly of joint. Apply joint flux, filler material and heat source per manufacturer's instructions to provide proper capillary action to fill the socket space and to achieve 100 percent of shear-line strength. For non-flanged valves in copper piping include screwed ends with end adapters to suit mechanical connections, unless filler jointing is specified or indicated for a given application. Remake copper joints which fail pressure tests with new materials including pipe or tubing fittings and filler metal.
7. Cut copper tubing square for mechanical joints; remove burrs with approved cutting and reaming tools. Do not work-harden copper surfaces; in case of doubt, cut off tube ends or anneal ends by heating to a temperature and air cooling per manufacturer's instructions.
8. Make joints in thermoplastic and thermoset plastic piping per manufacturer's instructions, except as more stringently required herein.

D. Joints Of Dissimilar Metals

1. At connections between piping systems, hangers and equipment of dissimilar metals, insulate, using dielectric insulating material, nonferrous piping against direct contact with the building steel by insulating the contact point of the hanger and pipe or the hanger and building steel. Test each point of dielectric insulation with an ohmmeter to insure proper isolation of dissimilar materials. Test shall be observed by the ARCHITECT-ENGINEER.

E. Joints - Welded/Brazed

1. Welding/brazing procedures and welder/brazer qualification, testing and certification shall comply with the latest revisions of all applicable ASME Boiler and Pressure Vessel Codes, Section 1 and ANSI/ASME Codes, B31 series.
2. Before any welding or brazing is performed, submit to the OWNER a copy of CONTRACTOR'S Standard (PQR) Welding/Brazing Procedure Specification (WPS)/(BPS) together with the related Procedure Qualification Record as required by Section IX of the ASME Boiler and Pressure Vessel Code. Exception. At the OWNER'S option, OWNER will furnish the Welding Procedure Specification and Procedure Qualification Requirements.
3. Before any welding/brazing is performed, submit to the OWNER a copy of the Welding Test or Welder/Brazer Performance Operator Qualification (WPQ)/(BPQ) Test as required by Section IX of the ASME Boiler and Pressure Vessel Code and in compliance with QW-320/QB-320 for currency of certification. Exception. At the OWNER'S option, OWNER will conduct Welding/Brazing Test or Welder/Brazer Operator Qualification Tests.
4. Each party performing welding shall be responsible for the quality of welding/brazing done by his organization and shall repair or replace any work not in accordance with these specifications.

- F. Instrument And Piping Specialty Connections
1. Install pressure sensing device connections, temperature sensing device thermal wells and similar piping specialty connections with full size fitting, reducer fitting, or welding coupling. Drilling and tapping of pipe wall for connections is prohibited.
 2. For Division 13 SECTIONS I & C Work, provide instrument connections, except thermal wells, with specified isolating valves at the point of connection to the system. For I & C work temperature sensors, provide connection fitting only. plug for testing.
 3. Locate instrument connections per manufacturer's instructions for accurate read-out of function sensed. Locate instruments for easy reading from normal operating levels.
 4. Provide pigtails for steam pressure gauges. Use pipe or flexible tubing and fittings on remote pressure gauge connections. Tubing shall be pressure rated copper with nonferrous fittings. Provide bar stock needle shut-off valves or pulsation dampeners as specified or indicated.
- G. Type CISP, Cast Iron Soil Pipe
1. Install per CISPI Cast Iron Soil Pipe and Fittings Handbook except as modified by the CONTRACT DOCUMENTS.
- H. Type CISP-H, Cast Iron Soil Pipe
1. Install per CISPI Cast Iron Soil Pipe and Fittings Handbook except as modified by the CONTRACT DOCUMENTS.
 2. Make joints using neoprene sleeve and stainless steel clamps per manufacturer's instructions to produce a liquid-tight joint without stressing sleeve.
- I. Grooved Couplings And Fittings
1. Use grooved couplings and fittings only in specified piping systems and where shown on the DRAWINGS. Select manufacturer's recommended gaskets for the service.
 2. Provide flexible couplings as shown. Grooved system components shall be obtained from a single manufacturing source. At pumps, provide welded piping joints, unless otherwise approved.
- J. Air Vents
1. Install air vent valves at all pressurized liquid piping systems and equipment water box high points and where indicated.
 2. Provide automatic air vent valves with isolation valves in condenser water box, water lines, except potable water lines, and drainage piping to points indicated or to points of disposal approved by the authorities having jurisdiction. Other vents shall be manual type installed in easily accessible locations.
- K. Drain Valves
1. Provide drain valves at piping systems low points, and at base of risers.
- L. Piping Drips
1. Provide drips at system low points. Use full line size to 4 inch NPS and not less than 6 inch for lines 6 inches NPS and larger.

2. Fit drips with plugged-end valve. For natural gas (and) (propane) (indicated piping) fit drips with plugs or end caps. Provide moisture traps at low points of compressed air piping.

M. Sleeves/Seals/Flashing

1. Refer to Division 15 Section “Basic Mechanical Material and Methods” for additional requirements. Comply with UL requirements for fire stopping.
2. Lay out sleeve installation work in advance of placing of slabs or construction of walls and set sleeves necessary to the work. Where pipe sleeves are required in existing slabs and masonry, use core drills to make the holes and set sleeves in place with a two-component epoxy adhesive. Plug sleeves indicated for future use.
3. Make sleeves which extend through floors, roofs, load bearing walls and fire barriers, continuous and of diameter large enough to accommodate pipe, insulation and jacketing, with a minimum 1 inch clearance.
4. Sleeves thru steel decks shall be welded with a continuous weld to the deck.
5. Set sleeves flush with walls, under sides of suspended slabs and top surface of floors in finished spaces. Set sleeves flush with walls and 2 inches above finished floor in manufacturing and equipment room spaces, unless otherwise indicated.
6. Seal pipe passing thru aboveground sleeves weathertight with packing and calking. Calk inserts exposed to weather.
7. Where piping passes through fire rated walls and floors, or walls and floors of buildings more than two stories high, fill voids and cavities around wall and floor penetrations with firestopping and smoke sealing materials to maintain the required fire-rated condition of substrate.
8. Pack the space between a pipe, bare or insulated, and the inside of a pipe sleeve or a construction surface penetration. Where a vapor barrier is required, fill the space between a pipe, bare or insulated, and the inside of a pipe sleeve or construction surface penetration with a calk to a depth of 3/8 inches. Clean surfaces to be calked of oil and grease. Cover with a loosely fitting metal collar on both sides of the wall.
9. Where indicated, seal pipe to sleeve with mechanically expandable inserts.
10. Set and extend plumbing vent lead flashing around pipe for a minimum of 6 inches from edge of pipe around the vent pipe for a minimum of 12 inches above the roof. Carry the lead sleeve inside the bottom of an inverted hub connection or vent fitting. Turn in the lead sleeve a minimum of 2 inches at the top of the vent and hammer smooth on the inside.

3.3 SUPPORTING ELEMENTS

A. Installation

1. Provide necessary piping and equipment supporting elements including. building structure attachments; supplementary steel; hanger rods, stanchions and fixtures; vertical pipe attachments; horizontal pipe attachments; anchors; guides; spring supports per the referenced codes, standards, and requirements specified. Support piping and equipment from building structure; not from roof deck, other pipe, duct or equipment.
2. Use copper plated or plastic coated supporting element in contact with copper tubing.
3. Shop or field prime paint or hot dip galvanize supporting element components.

4. Hang piping parallel with the lines of the building, unless otherwise indicated. Space piping and components so a threaded pipe fitting may be removed between adjacent pipes and so there will be not less than 1/2 inch of clear space between finished surfaces and piping. Arrange hangers on adjacent parallel service lines in line with each other.
5. In lieu of separate hangers, trapeze hangers for parallel service systems piping, may be placed on same elevation adjusted for proper pitch. Spacing of trapeze hangers shall be the closest interval required for any size pipe supported. Piping with common support elements shall have compatible support and vibration isolation. To maintain fixed positions on trapeze, provide bracing allowing for varying thermal expansion of each system supported.
6. Piping with pulsating fluid flow shall be supported independently of other piping.
7. Flange loads on connected equipment shall not exceed 75% of maximum allowed by equipment manufacturer. Flange loads in liquid containing systems shall be checked in the presence of the ARCHITECT-ENGINEER when piping is full of liquid. No flange load is allowed on pumps, vibration isolated equipment or flexible connectors.
8. Spring supports, within specified limitations. Constant support type, where significant vertical movement occurs and where necessary to avoid transfer of load from support to support or onto connected equipment; otherwise, variable support type located at points subject to vertical movement.
9. Incorporate pipe anchors into piping systems to maintain permanent pipe positions. Install four alignment guides for the piping adjacent to and on each side of pipe expansion loops and expansion joints to maintain alignment. Construct anchors to secure entire circumference of the pipe.
10. Where necessary, brace piping and supports against reaction, sway and vibration.
11. Install turnbuckles, swing eyes and clevises to accommodate temperature changes, pipe accessibility, and adjustment for load and pitch. Rod couplings are not acceptable.
12. Install hangers and supports for piping at intervals specified, at locations not more than 3 feet from the ends of each runout, and not over 25% of specified interval from each change in direction of piping.
13. Base the load rating for pipe support elements on loads imposed by insulated weight of pipe filled with water. The span deflection shall not exceed slope gradient of pipe. Use Schedule 40 and Schedule 80 ferrous pipe and copper tube supports per the following minimum rod size in inches maximum allowable hanger spacing in feet.

14. For concentrated loads, such as valves, reduce allowable span accordingly.

| <u>MAXIMUM ALLOWABLE SPAN</u> | | | | |
|-------------------------------|---------------------|--------------------------------|-----------------------------|------------------------|
| a. PIPE SIZE | <u>ROD SIZE</u> | <u>STEEL PIPE**</u> | | <u>COPPER TUBE</u> |
| | | <u>Steam & Liquids</u> | <u>Air & Gasses</u> | |
| 1/2 and smaller | 3/8 | 6 | 6 | 6* |
| 3/4 – 1 | 3/8 | 7 | 7 | 7 |
| 1-1/4 - 1-1/2 | 3/8 | 8 | 8 | 8 |
| 2 | 3/8 | 12 | 12 | 10 |
| 2-1/2 – 3 | 1/2 | 12 | 14 | 12 |
| 4 – 5 | 5/8 | 14 | 16 | -- |
| 6 | 3/4 | 16 | 20 | -- |
| 8 - 10 | 7/8 | 20 | 24 | -- |
| 12 and above | | As indicated on the DRAWINGS | | |

* Except where continuous support is specified.

** Bulk mains (fire protection service) using grooved couplings, provide two hangers for each 20 feet of length.

b. CAST IRON PIPE

All sizes 10 feet, but not less than two supports per pipe length.

c. PVC

1-1/2 and larger Support as recommended by the manufacturer.

15. Support vertical risers independently of connected horizontal piping whenever practical, with supports at the base and at intervals to accommodate system range of load with thermal conditions. Guide for lateral stability. Provide one rigid support for risers subject to expansion at approximately 1/3 point from the top or at base unless otherwise indicated. Fit horizontal piping contiguous to moving risers with two spring supports, spaced immediately adjacent to riser.
16. For risers at temperatures of 100 degF or less place riser clamps under fittings. Support carbon steel pipe at each operating level or floor and at not more than 15-foot intervals for pipe 2 inches and smaller, and at not more than 20 foot intervals for pipe 2-1/2 inches and larger.
17. After the piping systems have been installed, tested and placed in satisfactory operation, firmly tighten hanger rod nut and jam nut and upset threads to prevent movement of fasteners.
18. Attach pipe anchors and pipe alignment guides to the building structure as indicated. If not indicated, the method used is optional to the CONTRACTOR, subject to approval by the ARCHITECT-ENGINEER. In the case of structural steel, make attachment by clamping per the American Institute of Steel Construction Specification for the Design, Fabrication and Erection of Structural Steel for Building.
19. Attach supporting elements connected to structural steel columns to preclude vertical slippage and cascading failure. Column attachment includes compression bolting of

friction plates with a service duty factor of 5 on each flange face. Include on one plate a supported bolting shelf or other weldment for attachment of other supporting system elements. Submit complete shop drawings.

20. Locate pipe hangers and other supporting elements from roof purlins or top chord of jack trusses. Supporting elements shall not be supported from the top chord of roof or carrying trusses except at panel points. Total of all supported loads on a purlin shall be such as to produce a moment no greater than the moment produced by a one kip concentrated load at midspan of the purlin or greater concentrated load as indicated on the structural DRAWINGS. Total of all supported loads on the top chord of a jack truss between panel points shall be such as to produce a moment no greater than the moment produced by the uniform mechanical (utility) loads indicated on the structural DRAWINGS. When the total loads exceed the above criteria, provide additional support beams framed into a roof purlin or jack truss top chord or bearing on the roof or carrying truss top chord panel point. Unless otherwise shown by a structural calculation completed by the CONTRACTOR, purlins used for supporting electrical lighting fixtures and/or electrical power duct or cable tray shall be considered fully loaded and supplemental reinforcing for the purlins or auxiliary support steel shall be furnished and installed by the CONTRACTOR if necessary to utilize those purlins. Reinforcing at building structure shall be approved in writing by the ARCHITECT-ENGINEER.
21. Where eccentric loading beam clamps are approved and where other work is supported by similar eccentric loading support element from the same structural member, locate eccentric loading support elements to minimize structural member torsion load.

B. Pipe Anchors

1. For pipe line service temperatures under 250 degF, fabricate anchors from steel plate or structural shapes.
2. Construct anchors for pipe line service temperatures over 250 degF from piping components such as shaped nipples, saddles and flanges. For main anchors, weld a full size extra strong nipple with or without a saddle to the pipe. For intermediate anchors, weld a 2/3 line size extra strong nipple to the pipe. Weld a 150 PSIG slip-on flange to the bottom of the nipple and set in grout to provide anchor bolt area.

C. Pipe Guides

1. Control expansion joint movement by installing two rigid pipe guides on each side of the expansion joint. Spacing shall be as follows:

| Nom. Pipe Size (In.) | Maximum Distance | | Maximum Distance Between Intermediate Guides (Ft.) for tabulated pressures, PSIG | | | | | | | |
|-------------------------------|------------------------------------|-----------------------------|---|-----|-----|-----|-----|-----|-----|-----|
| | Exp. Joint to First Guide | First to Second Guide | 50 | 100 | 150 | 200 | 250 | 300 | 350 | 400 |
| 3 | 1'-0" | 3'-6" | 21 | 19 | 17 | 16 | 15 | 14 | 13 | 13 |
| 4 | 1'-4" | 4'-8" | 35 | 29 | 25 | 22 | 20 | 19 | 18 | 17 |
| 6 | 2'-0" | 7'-0" | 57 | 44 | 37 | 32 | 29 | 27 | 25 | 23 |
| 8 | 2'-8" | 9'-4" | 66 | 52 | 45 | 40 | 36 | 33 | 31 | 29 |
| 10 | 3'-4" | 11'-8" | 91 | 69 | 58 | 51 | 46 | 42 | 39 | 36 |
| 12 | 4'-0" | 14'-0" | 107 | 79 | 66 | 58 | 52 | 48 | 44 | 41 |

D. Supplementary Steel

1. Where it is necessary to frame structural members between existing members or where structural members are used in lieu of commercially rated supports, install such supplementary steel per the American Institute of Steel Construction Specification for the Design, Fabrication and Erection of Structural Steel for Buildings. Connections to existing steel shall be clamps unless otherwise approved by the ARCHITECT-ENGINEER.
2. Where these members are weather exposed, provide hot dip galvanized after fabrication (HDGAF) construction.

3.4 FIELD QUALITY CONTROL

A. General

1. Refer to Division 15 Section "General Mechanical Requirements." for additional requirements.

B. Flushing Work

1. GENERAL
 - a. Provide temporary and permanent piping, equipment and materials required for flushing work. Coordinate cleaning of connections to existing systems with ARCHITECT-ENGINEER.
 - b. If equipment and piping systems are not properly cleaned and flushed, pay for resultant damage, necessary cleaning and flushing of systems to which connection was made and subsequent inspection, at no increase in CONTRACT Sum.
 - c. Flush and drain dead ends.
 - d. Submit for approval proposed means of disposal of flushing water.
 - e. Flush and clean oil system as specified.
2. WATER SYSTEMS FLUSHING
 - a. Flush above ground potable water systems after successful hydrostatic and leak testing and cleaning operations per the following procedure:
 - 1) Open valves and pipe plugs at all system levels.

- 2) Clean system storage vessels, return tanks, sumps and basins.
- 3) Protect pumping equipment from damage.
- 4) Install temporary flushing filters or strainers.
- 5) Remove or disconnect system items which may be damaged during flushing.
- 6) Open and close valves to remove debris from body.
- 7) Drain system, disassemble, inspect, clean, repair and reassemble critical sectionalizing valves, especially gate valves, expansion provisions and permanent and temporary strainers.
- 8) Adjust control valves.
- 9) Close-up system for disinfection of specified service.
- 10) Dewater storage vessels and water heaters. Remove debris and deleterious substances. Inspect and repair equipment used for flushing operations.
- 11) Remove temporary strainers after systems have been in normal operation for not less than 2 weeks.

C. Disinfection Work

1. GENERAL

- a. Under direction of OWNER'S Water Treatment Laboratory, disinfect potable water systems and extension from existing systems connection with an approved chlorine solution as specified, prior to system acceptance in accordance with applicable codes. Apply chlorinated solution at the point of line origin nearest to existing chlorinated supply.

2. MATERIALS

- a. Chlorine solution encompasses not less than 50 parts per million (PPM) of available chlorine material composed of chlorine gas, calcium hypochlorite or commercial laundry bleach with minimum 5.25 percent available chlorine.
 - 1) Calcium hypochlorite;
 - a) "HTH".
 - b) "Perchloron".
 - c) "Pittchlor".
 - 2) Laundry bleach:
 - a) "Clorox".
 - b) "Roman Cleanser".

MATERIAL REQUIRED FOR 1000 GALLONS OF SOLUTION

| SOLUTION STRENGTH | 25 PPM | 50 PPM | 100 PPM |
|----------------------------|--------|--------|---------|
| CALCIUM HYPOCHLORITE (LBS) | 0.3 | 0.6 | 1.2 |
| LAUNDRY BLEACH (GALLONS) | 0.5 | 1.0 | 2.0 |

3. PROCEDURES

- a. Line being disinfected shall stand for a minimum of 24 hours. Disinfecting solution shall produce no less than 10 PPM chlorine residual at extreme end of line at the end of the retention period. After 24 hours flush out the disinfecting solution until the combined available chlorine residual is less than 1 PPM. Maintain flushing velocity at 6 FPS, unless higher velocities were achieved in previous flushing and unless otherwise approved.
- b. Bacteriological count shall be made by the Department of Public Health; if count is within United States Public Health Service Recommendations and local code

requirements, the system may be put into service. Repeat the disinfection process until specified results are obtained.

- c. Thoroughly disinfect pipe, valves, cocks, fittings hoses, containers and miscellaneous items used for connection of new piping to an existing facility, immediately prior to installation. Clean and disinfect materials involved with a solution containing not less than 2000 PPM available chlorine and flushed with potable, i.e., disinfected water. A 2000 PPM chlorine solution may be obtained by mixing 1 gallon of commercial laundry bleach per 25 gallons of water. Preclude contamination of disinfected materials prior to installation.

D. Cleaning Of Steam And Condensate Systems

1. Provide temporary vent piping to atmosphere, and protect architectural surfaces.
2. Support and bracing to restrain reactive forces.
3. Protect or disconnect system components which may sustain damage as a result of purging.
4. Close isolating valves.
5. Safety precautions and procedures shall be followed. Evacuate personnel not directly involved in purging.
6. Slowly open steam supply valve to purge steam lines using live steam.
7. After purging steam lines, open steam trap bypass valves to purge condensate lines to waste. Provide sufficient cooling water at drains to prevent discharge exceeding 135 degF into drainage system.
8. After completion of purging, replace removed components, disassemble and clean strainers and place system in normal service.

E. Steam Blow

1. DRAWINGS indicate temporary and permanent provisions for steam blow piping cleaning which shall be supplemented by the CONTRACTOR as required to accomplish the WORK.

F. Steam And Condensate Line Purging

1. Preliminary purging/lancing shall be done with high velocity/high pressure dry compressed air.
2. High pressure (to 30,000 psi), low volume, high velocity water may be used for purging.
3. Final purging shall be done with facility steam when it becomes available, or at the CONTRACTOR'S option, by use of rental, semi-trailer mounted, self-contained, high pressure boiler with capacity to generate velocities in excess of (6,000) feet per minute.
4. Flash rust and idle-time corrosion shall be prevented/controlled in acceptable manner.
5. Cleanliness shall be indicated by condition of blow-off dirt indicating target/catch surface. Submit proposed target construction details.
6. Provide temporary and permanent vent/blow-off piping to atmosphere, including, anchor/support and bracing to restrain reactive forces and protect or disconnect systems components which may sustain damage during or as a result of purging/blow-off. CONTRACTOR shall include the cost of removing and replacing architectural finishes/siding, and protecting and washing building surfaces to eliminate iron oxide dirt/stain. Use large polyethylene sheets where necessary.

7. Safety precautions shall be operational. Evacuate personnel not directly involved in purging from area of the WORK.
8. Open steam trap bypass valves, to purge “condensate” lines to waste. Provide sufficient cooling water at drain to prevent temperature exceeding 135 degF at drainage system. Run condensate to waste until approved by the water treatment laboratory as free of oil, iron oxide and deleterious substances and suitable for return to boiler.
9. After completion of purging, replace removed components, disassemble and clean strainers and any debris exposed valves and place system in safe mode, ready for next phase of WORK.
10. When steam system is operational, flush all condensate returns to waste with cooling to limit temperature in sewer as indicated on the DRAWINGS. Continue to purge as condensate is received from new piping in distribution system coming on line for first time, until condensate is deemed by the water treatment laboratory as fit quality for entry into boiler.

G. Piping Systems Testing

1. GENERAL

- a. Tests shall be witnessed by OWNER’S REPRESENTATIVE, BNL Pressure Safety Representative, and authorized inspectors (or representatives) having jurisdiction, which shall be timely notified by the CONTRACTOR to insure their being present during the testing.
- b. Perform initial service leak test per applicable requirements of ANSI/ASME B 31.1 Code for Power Piping on all piping systems.
- c. Prior to acceptance of the WORK, pressure test from the existing systems connections through completed systems in the presence of the ARCHITECT-ENGINEER and authorities having jurisdiction.
- d. Test piping systems per their respective and applicable governing codes and the requirements specified. Pressure test the pressure piping systems at 1-1/2 times maximum operating pressure, except as otherwise specified. Do not test plastic piping systems pneumatically.
- e. Provide necessary equipment and materials and make necessary test connections required to properly execute tests. Make tests before piping surfaces are concealed.
- f. Water for test purposes will be furnished by the OWNER. Obtain water from point(s) designated by the ARCHITECT-ENGINEER. Remove promptly temporary connections upon completion of testing or when directed by the ARCHITECT-ENGINEER.
- g. Tests shall be pneumatic for compressed air, utilizing dry, oil-free compressed air, carbon dioxide or nitrogen unless otherwise specified or approved. Use nitrogen for final test/purge where flammables/combustibles occur and where specified. Perform testing in two stages, i.e., preliminary and acceptance. Do not perform pneumatic testing until personnel not directly involved in performing the testing have been evacuated from the area. Pneumatic testing shall require preliminary testing at pressure not exceeding 5 PSI.
- h. Preliminary testing at 5 PSI requires swabbing joints with a commercial leak detector solution and subsequent observation for bubbles. In the event that testing demonstrates that leakage rate exceeds specified limits, determine the source(s) of

leakage, repair or replace defective materials and workmanship, and retest the installation to specified requirements. Test during steady state ambient temperature conditions. Non-metallic systems testing shall be per manufacturer's recommendations and requirements specified. Immediately repair detected leaks or defects in the system.

- i. Other than standard piping flanges, plugs, caps and valves, use only commercially manufactured expandable elastomer plugs for sealing off piping for test purposes. The safe test pressure rating of plug used shall be not less than two times the actual test pressure being applied. Expandable elastomer plugs shall not be used for piping which could develop sufficient reactive force to cause damage to a structure, other piping or cause moving of thrust or anchor provisions in case of blow-out.
 - j. Take precautions to vent the expansive force of compressed air trapped during high pressure hydrostatic testing to preclude injury and damage.
 - k. Components shall be removed from piping systems during testing whenever the component may sustain damage due to test pressure or test media. After completion of the test, the component shall be reinstalled and a test shall be reapplied at the component pressure rating.
 - l. System components such as valves shall be checked for functional operation under system test pressure. If the hydrostatic test pressure exceeds the valve manufacturers rating for hydrostatic seat test, the termination block valves shall remain open during the test and the system shall be blocked by other means. Existing steam and hot water piping connected to piping to be tested shall be shut off, drained and cooled before testing.
 - m. Prepare and maintain test records of piping systems tests. Records shall show ARCHITECT-ENGINEER and CONTRACTOR personnel responsibilities, dates, test gage identification numbers, ambient temperature, pressure ranges, rates of pressure drop and leakage rates. Two record copies of acceptance tests shall be delivered to the ARCHITECT-ENGINEER after acceptance.
2. **POTABLE WATER SUPPLY MAINS**
- a. Test backflow prevention at connections between potable water and nonpotable water for proper functioning under conditions normal to application. Test shall be by Certified Tester.
3. **GRAVITY DRAINAGE PIPING SYSTEMS TESTING**
- a. Prior to acceptance of the work, test completed systems in the presence of the ARCHITECT-ENGINEER and authorities having jurisdiction.
 - b. Test drainage piping systems per their respective and applicable governing codes and the requirements specified in this SECTION. Provide necessary equipment and materials and make necessary test connections required to properly execute tests.
 - c. Irrespective of any regulation to the contrary, test drainage and waste piping hydraulically by filling system to its highest point or, whichever is greater, at a static head of 10 feet. Leakage at any joint shall be sufficient cause for rejection and renewal of joint unless joint can be calked as specified or taken up sufficiently to stop leakage.
 - d. Air tests may be substituted in lieu of hydraulic tests by forcing air into the closed system at a uniform pressure sufficient to balance a column of 10" HG in height or a pressure of 5 PSI.

- e. Under any of the previously described tests, the water pressure shall remain constant, after stabilization, for not less than fifteen minutes without any further addition of water.
4. ACCEPTANCE PRESSURE TESTING
- a. Perform acceptance pressure testing as follows:

| Service | Nominal Oper. Press. (PSI) | Test Type | Test Press (PSI) | Permissible Press. Drop & Hold Period (PSI/Hours) |
|---------------------|----------------------------------|-----------|---------------------|---|
| Chilled Water | 110 | Hydro | 165 | 2/2 |
| City Water | 110 | Hydro | 165 | 2/2 |
| Condensate, Gravity | | Hydro | 150 | 2/2 |
| Cooling Tower Water | 35 | Hydro | 150 | 2/2 |
| Instrument Air | 115 | Pneu | 175 | 2/2 |
| Potable Water | 60 | Hydro | 150 | 2/2 |
| Steam/Condensate | 125 | Hydro | 180 | 2/2 |

- b. Test unlisted systems in accordance with applicable code.
- c. If testing demonstrates leakage, determine the source(s) of leakage, repair or replace defective materials and workmanship, and retest the installation to specified requirements.
- d. Remake leaking gasket joints with new gaskets and new flange bolting, destroy old bolting. Where welded joints fail, submit proposed method of repair for approval by the ARCHITECT-ENGINEER and authorities having jurisdiction.

END OF SECTION

| Revision History | |
|------------------|----------|
| Date | Rev. No. |
| A | 0 |
| B | 0 |
| C | 0 |
| D | 0 |
| E | 0 |
| F | 0 |
| 02-19-09 | 0 |
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